Introduction

This website contains some background materials on VoIP accessibility intended for review in advance by attendees at the FCC Solutions Summit. The main sections are:

- VoIP Has Many Facets (see page 8)
- Potential Barriers (see page 11)
- Potential Opportunities (see page 15)
- The Importance of Standards
- The VoIP Accessibility Chain
- The Information Burden

Much of the information on this site was provided by Summit presenters. We are especially grateful to Gunnar Hellstrom of Omnitor for his input into the barriers, opportunities, and standards sections.

The FCC has an excellent informational page on VoIP, largely for consumers considering VoIP for personal or small-scale use.

The Many Facets of VoIP

VoIP is not one product or service; it has many facets. Different parts of the telecom industry (manufacturers, carriers, software developers, system integrators, and more) play different roles in VoIP implementation. Users with disabilities may be confronting VoIP as employees, system administrators, or residential customers. The different facets can either extend or retrict telecom accessibility, as shown in the VoIP Facets table.

Positive and Negative Accessibility Implications of VoIP

New technologies have often been a two-edged sword for people with disabilities. For example, the computer's graphical user interface offered improved access for people with cognitive impairments, but originally excluded people who could not see the icons on the screen or manipulate the mouse. It may be the same with VoIP; certainly the policy air is filled with panics and panegyrics. In an effort to identify the concrete accessibility issues facing us, we have prepared two tables: Potential VoIP Accessibility Barriers and Potential VoIP Accessibility Opportunities.

Importance of Standards

VoIP requires successful interoperation between several pairs of technology elements. For example, peer-to-peer VoIP over the Internet depends on the following:

- that the microphone works with the sound card
- that the sound card works with the rest of the PC hardware
- that the PC hardware works with the operating system
- that the operating system works with the VoIP softphone
- that the operating system works with the networking hardware
- that the networking hardware and software work with the access network
- that the access network works with the ISP
- that the ISP works with the Internet backbone
- ... and back again on the receiver's side until the sound card works with the speaker

Obviously, most of these are not specific to VoIP. But the chain of interoperability is vulnerable at all points. Standards strengthen this chain by creating and maintaining public agreements about how the links are to be shaped and joined.

Many variations and different protocols, and few gateway services between them create fragmentation and less usability for all protocols, because you cannot reach everybody from the same service. The telephone network was created when such tendencies were cancelled by regulation for the benefit of voice users who now have a universal voice network. What forces can make VoIP and IP Multimedia the true interoperable super-network giving higher functionality for all with reachability to all regardless of what operator or equipment manufacturer they have?

Even if voice and video is implemented with compatibility according to VoIP standards, the real time text component is not, even when there are well established real time text conversation standards for the major VoIP environments.

In order to gain the described benefits, it requires co-ordination and keeping back the temptation to rush away in various directions with different solutions to similar problems. That is the big challenge! Avoid fragmentation to gain in volume and uniformity to get a snowball effect. How likely is it that we can require multimedia access to emergency services if there are 10 variants of access protocols? How can the positive forces be created that can cause harmonization and concentration on a very small set of protocols?

Luckily, many of the standards organizations concerned with interoperability and communication protocols include accessibility experts. More work needs to be done, of course, but there has already been much progress.

VoIP and the "Accessibility Chain"

Just as the chain of interoperability can be broken by one product that does not comply with standards, the chain of accessibility is vulnerable. The accessibility features built into mainstream products must work with related features in other mainstream products, or with assistive technologies. For example, a VoIP system may offer text communication over IP, but at some point there must be a way to communicate by text to a TTY. This can be built into the VoIP system, or it can be a compatibility feature with assistive technology network products that act as TTY gateways. Either way, there are technical issues to address that are similar to standard interoperability issues; there are also some issues that are unique to accessibility:

- assistive technology firms may lack the technical resources needed to "keep up" with mainstream technological developments
- the assistive technology industry as a whole, being composed of a few small firms, has not developed a robust standards environment for its own products
- given the shortage of standards, mainstream technology designers may develop compatibility with only one model of assistive technology
- mainstream developers may not understand user needs in enough detail because people with disabilities are by definition atypical
- mainstream developers may not understand how people actually use assistive technologies and may focus only on technical compatibility issues

There are probably other issues. The point is that the strength of the VoIP environment may be one of its weaknesses as far as accessibility is concerned.

What is VoIP's strength? A highly decentralized, low-barrier-to-entry industry environment where value can be added at any point encourages rapid innovation in products and services, as well as low prices. In many ways, VoIP may be the most convincing and powerful argument ever made in favor of breaking up telephone monopolies.

VoIP potentially enables almost anyone to create a new telecommunications product or service, because it is not necessary to build or invest in a worldwide network. Because developers of those new products and services have low costs, they can focus on smaller markets. One of these markets may be people with disabilities. It is entirely possible that some companies — maybe even current assistive technology companies — will offer assistive network services for VoIP. That would be a wonderful development.

But it wouldn't essentially solve the accessibility problem, because we'd still have the same issues of the compatibility and interoperability between mainstream and assistive technologies. And a highly decentralized industry means that there is another potential set of problems based on information about accessibility.

The VoIP Information Burden

...on Industry

If we had a telecommunications monopoly where all hardware, software, and networks came through one provider (public or private), information flow about accessibility would be simple. The company would probably have a large accessibility office with good connections with public agencies and regulators, as well as internal working relationships that fostered accessibility improvements. The level of commitment would be clear to everyone involved. This is not to say that all problems would magically disappear, but there would not be much confusion about what the problems were or what the next steps should be.

In fact, that is what we had in some jurisdictions. In California circa 1980, Pacific Bell had a large disability services office, with national support from Long Lines, Bell Labs, Western Electric, and other parts of the Bell System. Pacific Bell was able to assign field engineers to individual customers, who designed, built, and maintained highly customized telephones. Those field engineers were free to inform themselves about the needs of people with disabilities and develop the solutions they wanted. Correspondingly, those solutions were guaranteed to work, because the field engineers were embedded in the one company that was responsible for end-to-end operations.

Today's telecom engineers faced with addressing accessibility have no such luxury. Their companies may compete with each other, making cooperation tentative. Upper management may make decisions on new platforms and standards adoption that swamp or ignore the accessibility issue. Staff churn and corporate re-engineering mean that scarce accessibility wisdom are being discarded. All these result directly from today's competitive telecom environment that otherwise has provided unique benefits.

The bottom line is: what will the information cost be for a VoIP engineer in Company X to learn about an accessibility solution required in a new product? It may require research, attending meetings, reading up on standards, and testing, all the time navigating through a jungle of companies, technologies, and consultants. If that information cost is too high, it will not be paid. For many of the

newer, smaller firms — the ones most often pointed to as the engines of VoIP innovation — it may almost always be too high.

...on End Users

Now consider the information burden on consumers with disabilities. That community's innovators and early adopters consist of a few thousand technologically sophisticated, advocacy-oriented people with disabilities, who know how to use their personal information networks to find out about accessible products. Most of the rest of the disability demographic is lower in income, less well educated, and more socially isolated. To them VoIP (as with much of modern technology) may appear as an impossibly complex maze, navigating through which may lead them to a goal they are not convinced they want. They may have had enough disappointments trying to use technology to lead to a profound sense of pessimism.

Their bottom line is: how far down in the user manual will they have to dive to find something that addresses their disability? What will it take to explain their needs to a customer service representative? Can they stand the need to communicate with a mainstream company and an assistive technology company to solve a problem? Consumers pay information costs as well, and have to make the same kind of "is it worth it?" decisions.

VoIP Facets

VoIP is not one product or service; it has many facets. Different parts of the telecom industry (manufacturers, carriers, software developers, system integrators, and more) play different roles in VoIP implementation. The different facets can either extend or retrict telecom accessibility, as shown in the table below.

	Definition	Negative Implication	Positive Implication
Segment	VoIP is used in a transmission facility for a portion of a PSTN, but calls begin and end on non-VoIP equipment. Late Breaking News: On April 21, 2004 the FCC ruled that this is a "telecommunications service", and therefore regulated.	"VoIP insertion" is unknown to and uncontrolled by the end user so accommodation is not possible; TTY performance and audio quality may be degraded.	Lower cost to carriers may result in less expensive service.
PBX	VoIP is used as the only protocol within a private network (owned and managed by an organization such as a company, municipality, university, etc.). The PBX is connected to the public network.	The management of the organization purchasing the PBX may not consider needs of users with disabilities. PBX selected by the organization may lack important	Voice and data integration may allow improved accessibility within organization and to external callers, such as unified voice and text messaging, TTY gateway.

		accessibility features. The organization may administer the PBX so as to limit its accessibility. Employees with disabilities may not be able to choose accessibility solutions (for example, if the PBX uses only inaccessible proprietary phones). Inaccessibility may affect both employees and callers from PSTN.	
Hardware	Device designed to be used for VoIP calls, including phones, adapters, and routers	Phones may have been designed without attention to the accessibility of physical controls, TTY connectability, and displays	
PBX softphones	Software that emulates a PBX phone's functionality, sometimes integrated with related applications such as email and instant messaging.	Softphones available for any given PBX may not be accessible.	Some softphones are highly compatible with assistive technologies. Some softphones have their own

			screen reading capability. Hard of hearing users can select audio output devices and adjust them for optimal use.
Internet peer-to-peer softphones	A softphone intended for a PC user to place and receive direct VoIP calls over the Internet, without a carrier.	Profusion of softphones may complicate finding one with the accessibility features needed by any given individual.	Low cost telecom service. Profusion of softphones may provide a wide range of accessibility features. Hard of hearing users can select audio output devices and adjust them for optimal use.

Potential Accessibility Barriers, Viewed in Context of Section 255 Guidelines

The table below shows for each Section 255 Guideline (the rows) whether there is a potential barrier in VoIP hardware, software, or networks. In some cases there is a direct comparison between current conventional telephony and VoIP.

Sec. 255 Guideline	Short description	Barriers Specific to VoIP That Are Rare or Absent in "Conventional" Telephony*
1193.33(a)	Product documentation and customer support	Carrierless operation (no phone company) means limited commitment to a business-to-consumer relationship.
1193.33(b)	Accessibility point of contact	Smaller, internet- or software-oriented firms may ignore business-to-consumer relationship.
1193.33(c)	Employee training	Smaller, internet- or software-oriented firms may lack significant employee training programs.
1193.37	Pass-through of codes/formats	TTY signal compatibility is known to be jeopardized in some implementations. Captioning and video description of videoconferencing may be jeopardized in some implementations. Not all routers or networks permit VoIP or IP multimedia
1193.41(a)	Operable without vision	Some VoIP softphones are not compatible with screen readers. Some VoIP hardware phones rely on hardware displays and softkeys with

		contextual meanings. At least one VoIP hardware phone model uses a single large touchscreen for operation.
1193.41(b)	Operable with low vision and limited or no hearing	Some VoIP hardware phones have small or hard to read displays.
1193.41(c)	Operable with little or no color perception	No VoIP-specific barriers
1193.41(d)	Operable without hearing	No VoIP-specific barriers
1193.41(e)	Operable with limited manual dexterity	Some VoIP hardware phones have hard-to-use controls, including touchscreens.
1193.41(f)	Operable with limited reach and strength	No VoIP-specific barriers.
1193.41(g)	Operable without time-dependent controls	No VoIP-specific barriers.
1193.41(h)	Operable without speech	No VoIP-specific barriers.
1193.41(i)	Operable with limited cognitive skills	Managing softphone installation and configuration may be hard to understand. Arranging for peer-to-peer service is complex. Some VoIP softphones have graphics-rich screens that may be hard to understand.
1193.43(a)	Availability of visual information	Some VoIP PBXs do not provide an audible method of delivering visual information. Some VoIP hardware phones have small

		or hard to read displays. Some VoIP softphones are not compatible with screen readers.
1193.43(b)	Availability of visual information for low vision users	Some VoIP softphones have graphics-rich screens that may be hard to navigate through and read. Some VoIP softphones are not compatible with screen magnifiers and high contrast settings.
1193.43(c)	Access to moving text	Some VoIP softphones use moving text methods that are not compatible with screen readers.
1193.43(d)	Availability of auditory information	Some VoIP PBXs do not provide a visual method of delivering audible information.
1193.43(e)	Availability of auditory information for people who are hard of hearing	Reduction in audio quality may reduce intelligibility. Loss of synchronization between audio and video in IP videotelephony reduces their intelligibility during speech-reading.
1193.43(f)	Prevention of visually-induced seizures	No VoIP-specific barriers.
1193.43(g)	Availability of audio cutoff	VoIP hardware phones without a separate headset jack cannot implement cutoff.
1193.43(h)	Non-interference with hearing technologies	Softphone use on a PC may cause additional interference.
1193.43(i)	Hearing aid coupling	No VoIP-specific barriers.
1193.51(a)	External electronic access	No VoIP-specific barriers.

1193.51(b)	Connection point for external audio processing	Many VoIP hardware phones have no separate headset jack.
1193.51(c)	Compatibility of controls with prosthetics	Touchscreens on some VoIP hardware phones may not be compatible with prosthetics.
1193.51(d)	TTY connectability	Many VoIP hardware phones have no way to connect a TTY.
1193.51(e)	TTY signal compatibility	TTY signal compatibility is jeopardized in some implementations.

* Note: The entry "no VoIP-specific barriers" in this table does not mean that VoIP is automatically accessible or conformant to that Sec. 255 Guideline. It only means that there is nothing unique to VoIP as a platform; many barriers continue to exist in "conventional" telephony as experienced by average users with disabilities.

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May 7, 2004
Solutions Summit: Disability Access and IP-Enabled Services
http://inclusive.com/trng/voip/

Potential Accessibility Opportunities: VoIP and Related IP-enabled Applications

Here is a table of the potential accessibility opportunities for VoIP, with applications in the rows and disability categories in the columns.

	Deaf	Hard of Hearing	Blind	Low Vision	Speech Impaired	Dexterity Impaired	Cognitively Impaired
Integrated, simultaneous voice, text, and video communication, wired and wireless	Sign language communication Voice carryover is easier to set up and use Video relay is easier to set up and use Captioned videoconferencing	Speech-reading Captioned videoconferencing			Hearing carryover is easier to set up and use Improved speech-to-speech using video	Wireless improves ease of use	Multiple media makes communication more compelling and intelligible
Integration with IP-based TRS							

(relay)							
Wideband audio (better audio quality)		Improved intelligibility			Improved intelligibility		
Full-featured two-way simultaneous text communication (full screen, fonts, emoticons, etc.)	Easier to use, more expressive than TTY				Easier to use, more expressive than TTY; easy to prepare utterances in advance, insert into message		
User profile automatically establishes individual preferences and network services (transcoding, relay, text macros, speech synthesis, etc.)	Easier to set up	Easier to set up	Easier to set up	Easier to set up	Easier to set up	Easier to set up; reduces mental effort Buddy list simplifies use	Easier to set up; reduces mental effort
User			Easier	Easier		Easier	Easier to

profile and account information can be used on multiple devices (home, work, and wireless phone) and public terminals with "follow me" service			to set up; skip steps on visual terminals	to set up; skip steps on visual terminals		to set up; reduces physical effort	set up; reduces mental effort
Multimedia emergency service	Improved access via text	Improved access via wideband audio			Improved access via wideband audio		Improved access by using video to explain emergency

IP Services and 9-1-1 "A Paradigm Shift"

Nate Wilcox

Vermont Enhanced 9-1-1

IP Services/9-1-1 Barriers

- Nomadic users
  - Location information
- TTY's
- No standardized approach to IP communication enhancements
  - Good recognition though
- QoS end to end for IP communications
  - Codec's, bandwidth and power.
- Current efforts and timelines

Nomadic VoIP Users

- Civil location is only accepted for 9-1-1 if it is validated.
- Validation usually takes 24 hours.
- Portable IP TA's get dial tone as soon as they are plugged in.
- Paradigm Shift - have broadband service providers validate location of end points.

TTY's

- Total character error rate for ToIP can have a negative impact on effective communications.
- Dropped packets can result in dropped emergency calls.
- IP communications drop packets to preserve bandwidth by design.
- Paradigm Shift -
  - Ensure a compression-less codec is used for 9-1-1 (i.e. G.711).
  - Promote technologies that improve throughput and use of alternate communication methods (SMS, 2 way paging etc.)

No Standardized Approach

- Chat and instant message sessions are not supported in Public Safety Answering Points (PSAP's)… officially
- Full streaming video is not supported.
- Paradigm Shift - create a platform that calls for a standardized approach to these technologies.
  - Migrate this capability to emergency responders.
  - Considerable work already done - BTW

Quality of Service

- Low bandwidth and certain Codec's can impact good communications with VoIP
  - Background noises
  - Good audio
- Loss of power.
- Paradigm Shift -
  - Education
  - Support and promote better technologies

What's Being Done?

- National Emergency Number Association
  - Tech and Ops Committee's working the issues
- Internet Engineering Task Force
  - Several RFC's have been written regarding emergency calling
- Alliance for Telecommunications Industry Solutions (ATIS)
  - Poised to provide ANSI accreditation to the standards once written

Timeline

- Standard for delivering calls to existing PSAP is completed - will be published next month.
  - No location
  - No nomadic/mobile support
- Standard(s) for an analogous solution TBC by end of year.
- Standard(s) for native end to end VoIP with support for all IP communications is “on going”.
  - Several Technical Information Document’s (TID) already completed.